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JC10 Rec'd PCT/PTO 08 FEB 2002

SUBSTITUTE FORM PTO-1390 U S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER
12816-044US1

U.S. APPLICATION NO. (If Known, see 37 CFR 1.5) 10/049252

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP00/07746	9 August 2000	9 August 1999

TITLE OF INVENTION
RECEPTION METHOD AND RECEIVER ARRAY FOR A DUPLEX TRANSMISSION SYSTEM

APPLICANT(S) FOR DO/EO/US
Heinrich Schenk

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)).
4. ☐ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☒ is attached hereto (required only if not communicated by the International Bureau).
   b. ☐ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ An English language translation of amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 16 below concern other documents or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
    ☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☐ Other items or information:
    ☒ English translation of International Search Report
    ☐
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Leroy Eason — Typed Name of Person Signing

JC10 Rec'd PCT/PTO 08 FEB 2002

U.S. APPLICATION NO. (IF KNOWN) 10/049252	INTERNATIONAL APPLICATION NO. PCT/EP00/07746	ATTORNEY'S DOCKET NUMBER 12816-044US1

17. ☒ The following fees are submitted:

Basic National Fee (37 CFR 1.492(a)(1)- (5)):

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040**

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890**

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO..... **$740**

International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4)..... **$710**

International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4)..... **$100**

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Claims	Number Filed	Number Extra	Rate		
Total Claims	19 - 20 =	0	x **$18**	$0.00	
Independent Claims	3 - 3 =		x **$84**	$0.00	
MULTIPLE DEPENDENT CLAIMS(S) (if applicable)			+ **$280**	$0.00	
TOTAL OF ABOVE CALCULATIONS =				$890.00	
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				$0.00	
SUBTOTAL =				$890.00	
Processing fee of **$130** for furnishing the English Translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f))				$0.00	
TOTAL NATIONAL FEE =				$890.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$0.00	
TOTAL FEES ENCLOSED =				$890.00	
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a. ☒ A check in the amount of $890.00 to cover the above fees is enclosed.
b. ☐ Please charge my Deposit Account No. 06-1050 in the amount of $0.00 to cover the above fees. A duplicate copy of this sheet is enclosed.
c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 06-1050. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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Faustino A. Lichauco
NAME

41,942
REGISTRATION NUMBER

Attorney's Docket No.: 12816-044US1 / S1692 SB/swi

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Heinrich Schenk
Serial No. : Unassigned
Filed : Herewith
Title : RECEPTION METHOD AND RECEIVER ARRAY FOR A DUPLEX TRANSMISSION SYSTEM

BOX PCT
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Washington, D.C. 20231

PRELIMINARY AMENDMENT

Prior to examination, please amend the application as follows:

In the specification:

On page 1, delete lines 4-9.

Prior to the paragraph at page 1, line 11 please add the following Heading as a new line:

--BACKGROUND--

Prior to the paragraph at page 4, line 33 please add the following Heading as a new line:

--SUMMARY--

Prior to the paragraph at page 6, line 16 please add the following Heading as a new line:

-- BRIEF DESCRIPTION OF THE DRAWINGS--

Prior to the paragraph at page 6, line 34 please add the following Heading as a new line:

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Signature

Leroy Jenkins
Typed or Printed Name of Person Signing Certificate

--DESCRIPTION--

On page 9, delete lines 1-27.

In the claims:

Cancel claims 1–10 without prejudice.

Add claims 11-19.

--11. (New) A method for receiving a received signal transmitted via a duplex transmission system, the method comprising:

receiving the received signal from a duplex transmission unit in the duplex transmission system;

sampling the received signal at twice a symbol rate of the received signal;

generating an echo compensation signal in an echo compensation device on the basis of a transmitted signal from the duplex transmission unit;

combining the echo compensation signal with the sampled received signal to obtain an echo-compensated received signal;

equalizing the echo-compensated received signal; and

outputting the echo-compensated received signal for further processing;

wherein after sampling at twice the symbol rate, the received signal, is equalized and the equalized received signal is sampled again at once the symbol rate and is supplied to the echo compensation device .--

--12. (New) The method of claim 11, wherein the received signal is equalized using a nonrecursive digital filter after the sampling at twice the symbol rate and before the sampling at once the symbol rate.--

--13. (New) The method of claim 12, wherein the nonrecursive digital filter has a set of coefficients unaltered during data transmission.--

--14. (New) A receiver arrangement for a duplex transmission unit, the receiver arrangement comprising:

a first sampling device for sampling a received signal from the duplex transmission unit at twice a symbol rate of the received signal;

an echo compensator device for producing an echo compensation signal on the basis of a transmitted signal from the duplex transmission unit, with the echo compensation signal being combined in the echo compensation device with the received signal sampled by the sampling device to obtain an echo-compensated received signal; and

a first equalizer for equalizing the echo-compensated received signal and for outputting the equalized and echo-compensated received signal for further processing;

wherein the first sampling device and the echo compensation device include a second equalizer arranged between the first sampling device and the echo cancellation device to which the received signal sampled at twice the symbol rate by the first sampling device is supplied for equalization; and

wherein a second sampling device is provided to sample the received signal equalized by the second equalizer at once the symbol rate and to supply it to the echo compensation device.--

--15. (New) The receiver arrangement of claim 14, wherein the second equalizer includes a digital filter.--

--16. (New) The receiver arrangement of claim 15, wherein the second equalizer includes a nonrecursive digital filter.--

--17. (New) The receiver arrangement of claim 16, wherein a set of coefficients of the second equalizer is set permanently.--

--18. (New) The receiver arrangement of claim 14, wherein the received signal is supplied to the first sampling device via a reception filter, the received signal being sampled at once the symbol rate by the second sampling device and being equalized by the second equalizer, the received signal being supplied to the echo compensation device via a digital high-pass

filter.--

--19. (New) The receiver arrangement of claim 18, wherein the first equalizer includes a digital nonrecursive filter with adaptively settable filter coefficients, the first equalizer having a decision feedback equalizer connected in series therewith, the decision feedback equalizer being configured to output the equalized and echo-compensated received signal for further processing.--

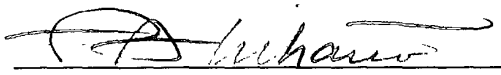
REMARKS

Applicant cancels claims 1-10 and adds claims 11-19 to more particularly point out and distinctly claim the invention. Applicant also amends the specification to conform to U.S. practice. No new matter is introduced.

Applicant asks that all claims be examined. Please apply any other charges or credits to Deposit Account No. 06-1050.

Respectfully submitted,

Date: 2/8/02



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Version with markings to show changes made

In the claims:

Claims 1-10 have been cancelled.

Patent Claims

1. A method for receiving a received signal (u(t)) transmitted via a duplex transmission system,
where a received signal (u(t)) received from a duplex transmission unit in the duplex transmission system is sampled at twice the symbol rate (2/T) of the received signal (u(t)),
where an echo compensation signal (yec(k·T)) is produced in an echo compensation device (6, 7) on the basis of a transmitted signal (x(k·t)) from the duplex transmission unit and is combined with the sampled received signal (y'(k·T)) in order to obtain an echo-compensated received signal (y(k·T)), and
where the echo-compensated received signal (y(k·T)) is equalized (8, 9) and is output for further processing,
characterized in that,
after the sampling (2) at twice the symbol rate (T/2), the received signal (u(t)) is equalized (3) and the equalized received signal is sampled again (4) at once the symbol rate (1/T) and is supplied to the echo compensation device (6, 7).

2. The method as claimed in claim 1,
characterized in that
the received signal (u(t)) is equalized using a nonrecursive digital filter (3) after the sampling (2) at twice the symbol rate (2/T) and before the sampling (4) at once the symbol rate (1/T).

3. The method as claimed in claim 2,
characterized in that
the coefficients (c_1.....c_n) of the nonrecursive digital filter (3) are not altered during data transmission.

4. A receiver arrangement for a duplex transmission unit,
having a first sampling device (2) for sampling a received signal (u(t)) from the duplex transmission unit at twice the symbol rate (2/T) of the received signal (u(t)),
having an echo compensator device (6, 7) for producing an echo compensation signal (yec(k·T)) on the basis of a transmitted signal (x(k·T)) from the duplex transmission unit, with the echo compensation signal (yec(k·T)) being combined in the echo compensation device (6, 7) with the received signal (y'(k·T)) sampled by the sampling device (2) in order to obtain an echo-compensated received signal (y(k·T)), and
having a first equalizer (8) for equalizing the echo-compensated received signal and for outputting the equalized and echo-compensated received signal (y(k·T)) for further processing,
characterized
in that the first sampling device (2) and the echo compensation device (6, 7) have a second equalizer (3) arranged between them to which the received signal (u(t)) sampled at twice the symbol rate (2/T) by the first sampling device (2) is supplied for equalization (3), and
in that a second sampling device (4) is provided in order to sample the received signal (u(t)) equalized by the second equalizer (3) at once the symbol rate (1/T) and to supply it to the echo compensation device (6, 7).

5. The receiver arrangement as claimed in claim 4, characterized
in that the second equalizer (3) is a digital filter.

6. The receiver arrangement as claimed in claim 5, characterized

in that the second equalizer (3) is a nonrecursive digital filter.

7. The receiver arrangement as claimed in claim 6, characterized
in that the coefficients (c_1.....c_n) of the second equalizer (3) are set permanently.

8. The receiver arrangement as claimed in one of claims 4-7,
characterized
in that the received signal (u(t)) is supplied to the first sampling device via a reception filter (1), and
in that the received signal (y'(k·T)) sampled at once the symbol rate (1/T) by the second sampling device (4) and equalized by the second equalizer (3) is supplied to the echo compensation device (6, 7) via a digital high-pass filter (5).

9. The receiver arrangement as claimed in one of claims 4-8,
characterized
in that the first equalizer (8) is a digital nonrecursive filter with adaptively settable filter coefficients, and
in that the first equalizer (8) has a decision feedback equalizer (9) connected in series with it which outputs the equalized and echo-compensated received signal (y(k·T)) for further processing.

10. The use of a receiver arrangement as claimed in one of claims 4-9 in a duplex pulse amplitude modulation transmission system.

Reception method and receiver arrangement for a duplex transmission system

The present invention relates to a reception method in accordance with the precharacterizing clause of claim 1 and to a receiver arrangement in accordance with the precharacterizing clause of claim 4 for a duplex transmission system in which, in particular, pulse amplitude modulated signals are transmitted.

The transmission of data in the baseband using pulse amplitude modulation (PAM) is advantageous particularly when additional signals, such as voice signals for an additional telephone channel, do not need to be transmitted simultaneously in the audio frequency range. In contrast to carrier modulated transmission systems, such as QAM (quadrature amplitude modulation) or DMT (discrete multitone modulation) transmission systems, PAM transmission systems use virtually the whole frequency range starting at a bottom cut-off frequency, which is essentially determined by the characteristics of the line access circuit.

Pulse amplitude modulation is also used in duplex transmission systems, inter alia, in which data are transmitted simultaneously in both directions of the transmission channel or of the transmission line. Such duplex transmission systems require echo compensation in order to suppress the crosstalk from their own transmitter to the receiver in the same transmission unit, which would result in echo effects. The echo compensation simultaneously manages to make it possible to use the available bandwidth in optimum fashion at both ends, so that such transmission systems are distinguished, in particular, by a relatively long range for a prescribed interference environment.

Figure 3 shows the basic arrangement of a PAM receiver in such a duplex data transmission system. A received

signal u(t) is filtered by an analogue input filter 1 and is then sampled at the symbol rate 1/T by a sampler 2, so that these samples of the received signal are available at intervals of $k \cdot T$. Instead of the analogue input filter 1, it is also possible to use a digital input filter if the sampling frequency is chosen to be appropriately high. Sampling at the symbol rate 1/T can be followed by a further filter stage 5, which is generally produced by a digital high-pass filter. This further filter 5 is used, in particular, to suppress low frequency interference, such as the offset, and to improve the transient response. An echo compensator 6 produces an echo compensation signal $yec(k \cdot T)$ on the basis of the transmitted data $x(k \cdot T)$ from the transmitter in the same duplex transmission unit and subtracts it from the sampled and equalized received signal $y'(k \cdot T)$ using the adder 7 shown in figure 3. The received signal echo-compensated in this way is finally equalized and is output as $y(k \cdot T)$ for further processing, in particular for demodulation, so that the respectively transmitted data can be recovered. The linear equalizer 8 used is generally a digital nonrecursive filter whose coefficients respectively need to be set adaptively to the current transmission channel. Since the received-signal values sampled at the symbol rate 1/T, filtered and freed of echo are supplied to the equalizer 8 as input signal, the equalizer 8 is also referred to as a T equalizer. Downstream of the equalizer 8, a decision feedback equalizer 9 is normally used in addition which compensates for the post-transients of the pulse response for the respective transmission channel and generally results in a better transmission response.

In many instances of application, a better transmission response can be attained for the same interference environment if an equalizer is used whose input signal is sampled at twice the symbol rate of the received

signal, i.e. at the frequency 2/T. Such an equalizer is therefore also referred to as a T/2 equalizer.

A corresponding receiver arrangement having such a T/2 equalizer is shown in Figure 4, where those elements which correspond to the elements shown in Figure 3 have been provided with the same reference symbols. As can be seen in Figure 4, the received signal u(t) is sampled at twice the symbol rate 2/T by the sampler 2 and is supplied to the echo compensator 6 via the digital high-pass filter 5. On account of the sampling frequency being doubled, the echo compensator has to produce two compensation values $y(k \cdot T/2)$ per received symbol in this case. The received signal echo-compensated in this way is supplied to the T/2 equalizer 8 and is sampled at the output of the T/2 equalizer at once the symbol rate 1/T by a further sampler 13 and is output to the decision feedback equalizer 9.

The fundamental drawback of this receiver arrangement is that the echo compensator 6, as has already been explained, has to produce two compensation values per received symbol, i.e. twice as many compensation values as in the case of the arrangement shown in figure 3. For this reason, the complexity of producing the echo compensator 6, which is the main portion of the total complexity anyway, is virtually doubled.

This is intended to be demonstrated by the illustration shown in figure 5, which shows a possible circuit arrangement for the echo compensator 6 shown in figure 4 for a transmission system having a T/2 equalizer 8. The echo compensator 6 essentially comprises two paths, with the upper path generating the components of the echo compensation signal $yec(k \cdot T)$ for the sampling instants $k \cdot T+T/2$, and the lower path generating the components of the echo compensation signal for the sampling instants $k \cdot T$. The compensation values

generated by the two paths using delay elements 14, multipliers 15 with settable multiplication coefficients $h_{1,1}.....h_{N,1}$ and $h_{1,2}.....h_{N,2}$, and adders 16 are forwarded alternately at the output. An echo compensator for a transmission system having a T equalizer would, by contrast, require only one path, since in that case only one compensation value would need to be generated per received symbol.

DE-C-211 029 discloses a generic reception method for duplex transmission and a generic associated receiver arrangement which sample a received signal at twice the symbol rate of the received signal before echo compensation and equalization, in accordance with the precharacterizing clause of claims 1 and 4.

DE 30 09 450 A1 discloses an echo cancellation arrangement for homochronous data transmission systems, where the received signal is also sampled at once the symbol rate, but only after echo compensation.

"Adaptive Sprecherecho-Kompensation in Modems für die Duplex-Datenubertragung im Fernsprechnetz" [Adaptive Speaker Echo Compensation in modems for duplex data transmission in the telephone network], Frequenz 6/1983, pp. 145 - 153, likewise discloses respective sampling before and after the echo compensation.

DE 38 28 623 C2 discloses a method for producing phase shifts for phase modulation or phase keying or quadrature amplitude modulation.

The present invention is therefore based on the object of proposing a reception method for a duplex transmission system and also an appropriate receiver arrangement, where comparable transmission characteristics to those when using a T/2 equalizer can be achieved but, at the same time, the increased

complexity of producing the echo compensator is avoided.

The invention achieves this object by means of a method having the features of claim 1 and a receiver arrangement having the features of claim 4. The subclaims respectively define preferred and advantageous embodiments of the present invention. Claim 10 gives a use for the receiver arrangement for a duplex pulse amplitude modulation transmission system.

The invention proposes first sampling the received signal at twice the symbol rate and supplying it to an additional equalizer, namely a T/2 equalizer. At the output of this additional equalizer, the equalized received signal is sampled at the symbol rate, so that only every second value is supplied to the echo compensator and used for further processing.

The other components of the receiver arrangement can then correspond to the arrangement shown in Figure 3 having a T equalizer.

The additional equalizer used may, in particular, be a digital nonrecursive filter whose input receives the received-signal values present at twice the symbol rate of the received signal, with the output of the digital nonrecursive filter outputting received-signal values at once the symbol rate. In this context, the coefficients of the digital nonrecursive filter must not change during data transmission and should therefore be set permanently.

The advantage of the present invention is that the echo compensator used for echo compensation need generate only one compensation value per received signal output by the additional equalizer, and hence can be produced with relatively low circuit complexity. In particular, the complexity of implementation is comparable to that

for an echo compensator for a duplex transmission system having a T equalizer (cf. figure 3). On the other hand, the present invention can be used to achieve such a good transmission response as is comparable to that of a system having a T/2 equalizer.

The present invention is particularly suitable for use in duplex PAM data transmission systems. In principle, however, the present invention can also be used in any other duplex transmission systems.

The invention is explained in more detail below using a preferred exemplary embodiment with reference to the appended drawing.

Figure 1 shows a block diagram of a receiver arrangement for a duplex transmission system based on the present invention,

figure 2 shows a possible circuit design for a T/2 equalizer shown in figure 1,

figure 3 shows a block diagram of a known receiver arrangement for a duplex transmission system based on the prior art,

figure 4 shows a block diagram of another known receiver arrangement for a duplex transmission system based on the prior art, and

figure 5 shows a possible circuit design for an echo compensator shown in figure 4.

Figure 1 shows an inventive receiver arrangement for a duplex PAM data transmission system, where the elements corresponding to the elements shown in figures 3 and 4 have been provided with the same reference symbols.

As figure 1 shows, a received signal u(t) is first filtered using an (analog or digital) input filter 1 and is sampled at twice the symbol clock or twice the symbol rate of the received signal by a sampler 2. This sampled signal is supplied to an additionally inserted unit, namely a T/2 equalizer 3, which can also be referred to as a compromise equalizer. A further sampler 4, which samples the equalized received signal at once the symbol rate, is used to take only every second sample at the output of this additional T/2 equalizer 3 for further processing. The rest of the circuit arrangement corresponds to the known circuit arrangement having a T equalizer, as shown in figure 3 and already explained in detail. Hence, by way of addition, reference is made to the statements regarding figure 3 in relation to the other elements of the receiver arrangement shown in figure 1.

It should be noted, in particular, that the echo compensator shown in figure 1 need generate only one compensation value per symbol, and hence can be produced with correspondingly low complexity.

The T/2 equalizer 3 used in accordance with figure 1 can, in particular, be formed by a digital nonrecursive filter whose input receives the received-signal values present at twice the symbol rate of the received signal u(t), the digital nonrecursive filter in combination with the sampler 4 outputting received-signal values at once the symbol rate at the output.

A block diagram of an appropriate equalizer 3 is shown by way of example in figure 2. As can be seen in figure 2, this digital nonrecursive filter 3 comprises a plurality of T/2 delay elements 10 and also multipliers 11 arranged in the individual forward paths, the output values of the individual forward paths being added by an adder 12 and supplied to the sampler 4 as output signal. The coefficients $c_1 \ldots . c_n$ for these multipliers

11 must not change during data transmission and should therefore be set permanently. When proportioning these coefficients $c_1 \ldots\ldots c_n$, however, the characteristics of a particular transmission channel in the respective duplex data transmission system can be taken into account. The actual matching to the respectively current transmission channel is performed, as has already been explained, by the adaptive T equalizer 8, to which the received-signal values equalized by the T/2 equalizer 3, filtered using the filters 1 and 5 and echo-compensated by the echo compensator 6 are supplied.

List of Reference Symbols

1	Input filter
2	Sampler
3	T/2 equalizer
4	Sampler
5	Digital filter
6	Echo compensator
7	Adder
8	Linear equalizer
9	Decision feedback equalizer
10	Delay element
11	Multiplier
12	Adder
13	Sampler
14	Delay element
15	Multiplier
u(t)	Received signal
T	Symbol period
k	Sampling index
x(t)	Transmitted signal
y'(k·t)	Equalized received signal
yec(k·t)	Echo compensation signal
y(k·t)	Equalized and echo-compensated received signal
$h_{1,1}$ ...$h_{N,2}$	Multiplication coefficient
$c_1 \ldots c_n$	Multiplication coefficient

Patent Claims

1. A method for receiving a received signal (u(t)) transmitted via a duplex transmission system,
where a received signal (u(t)) received from a duplex transmission unit in the duplex transmission system is sampled at twice the symbol rate (2/T) of the received signal (u(t)),
where an echo compensation signal (yec(k·t)) is produced on the basis of a transmitted signal (x(k·t)) from the duplex transmission unit and is combined with the sampled received signal (y'(k·T)) in order to obtain an echo-compensated received signal (y(k·t)), and
where the echo-compensated received signal (y(k·t)) is equalized (8, 9) and is output for further processing,
characterized in that,
after the sampling (2) at twice the symbol rate (T/2), the received signal (u(t)) is equalized (3) and the equalized received signal is sampled again (4) at once the symbol rate (1/T) and is supplied to the echo compensation device (6, 7).

2. The method as claimed in claim 1,
characterized in that
the received signal (u(t)) is equalized using a nonrecursive digital filter (3) after the sampling (2) at twice the symbol rate (2/T) and before the sampling (4) at once the symbol rate (1/T).

3. The method as claimed in claim 2,
characterized in that
the coefficients (c_1.....c_n) of the nonrecursive digital filter (3) are not altered during data transmission.

4. A receiver arrangement for a duplex transmission unit,

having a first sampling device (2) for sampling a received signal (u(t)) from the duplex transmission unit at twice the symbol rate (2/T) of the received signal (u(t)),

having an echo compensator device (6, 7) for producing an echo compensation signal (yec(k·t)) on the basis of a transmitted signal (x(k·t)) from the duplex transmission unit, with the echo compensation signal (yec(k·t)) being combined with the received signal (y'(k·t)) sampled by the sampling device (2) in order to obtain an echo-compensated received signal (y(k·t)), and

having a first equalizer (8) for equalizing the echo-compensated received signal and for outputting the equalized and echo-compensated received signal (y(k·t)) for further processing,

characterized

in that the first sampling device (2) and the echo compensation device (6, 7) have a second equalizer (3) arranged between them to which the received signal (u(t)) sampled at twice the symbol rate (2/T) by the first sampling device (2) is supplied for equalization (3), and

in that a second sampling device (4) is provided in order to sample the received signal (u(t)) equalized by the second equalizer (3) at once the symbol rate (1/T) and to supply it to the echo compensation device (6, 7).

5. The receiver arrangement as claimed in claim 4, characterized

in that the second equalizer (3) is a digital filter.

6. The receiver arrangement as claimed in claim 5, characterized

in that the second equalizer (3) is a nonrecursive digital filter.

7. The receiver arrangement as claimed in claim 6,

characterized
in that the coefficients (c_1.....c_n) of the second equalizer (3) are set permanently.

8. The receiver arrangement as claimed in one of claims 4-7,
characterized
in that the received signal (u(t)) is supplied to the first sampling device via a reception filter (1), and
in that the received signal (y'(k·t)) sampled at once the symbol rate (1/T) by the second sampling device (4) and equalized by the second equalizer (3) is supplied to the echo compensation device (6, 7) via a digital high-pass filter (5).

9. The receiver arrangement as claimed in one of claims 4-8,
characterized
in that the first equalizer (8) is a digital nonrecursive filter with adaptively settable filter coefficients, and
in that the first equalizer (8) has a decision feedback equalizer (9) connected in series with it which outputs the equalized and echo-compensated received signal (y(k·t)) for further processing.

10. The use of a receiver arrangement as claimed in one of claims 4-9 in a duplex pulse amplitude modulation transmission system.

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

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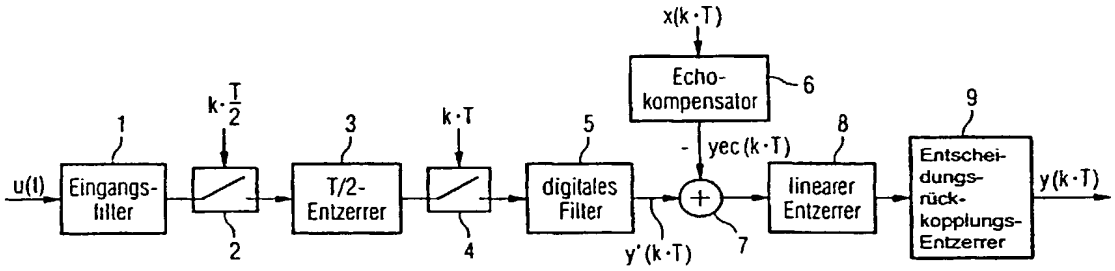
Veröffentlicht:
— *Mit internationalem Recherchenbericht.*
— *Vor Ablauf der für Änderungen der Ansprüche geltenden Frist; Veröffentlichung wird wiederholt, falls Änderungen eintreffen.*

Zur Erklärung der Zweibuchstaben-Codes, und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

(54) Title: RECEPTION METHOD AND RECEIVER ARRAY FOR A DUPLEX TRANSMISSION SYSTEM

(54) Bezeichnung: EMPFANGSVERFAHREN UND EMPFÄNGERANORDNUNG FÜR EIN DUPLEX-ÜBERTRAGUNGS-SYSTEM



1...INPUT FILTER
3...EQUALIZER
5...DIGITAL FILTER
6...ECHO COMPENSATOR
8...LINEAR EQUALIZER
9...DECISION FEEDBACK EQUALIZER

(57) Abstract: The invention relates to a duplex transmission system, wherein an echo compensation signal (yec(k·t)) is generated which is combined with a receive signal (u(t)) to prevent crosstalk from the own transmitter to the receiver. Before feeding the receive signal to the echo compensation device (6, 7), the receive signal is initially scanned with the double symbol rate, equalized and subsequently scanned once again with the simple symbol rate so that only one compensation value per receive signal has to be generated by the echo compensation device (6, 7).

(57) Zusammenfassung: In einer Duplex-Übertragungseinheit wird ein Echokompensationssignal (yec(k·t)) erzeugt, welches mit einem Empfangssignal (u(t)) zur Vermeidung von Übersprechen vom eigenen Sender auf den Empfänger kombiniert wird. Vor der Zuführung des Empfangssignals zu der Echokompensationseinrichtung (6, 7) wird das Empfangssignal zunächst mit der doppelten Symbolrate abgetastet, entzerrt und anschliessend nochmals mit der einfachen Symbolrate abgetastet, so dass von der Echokompensationseinrichtung (6, 7) lediglich ein Kompensationswert pro Empfangssymbol generiert werden muss.

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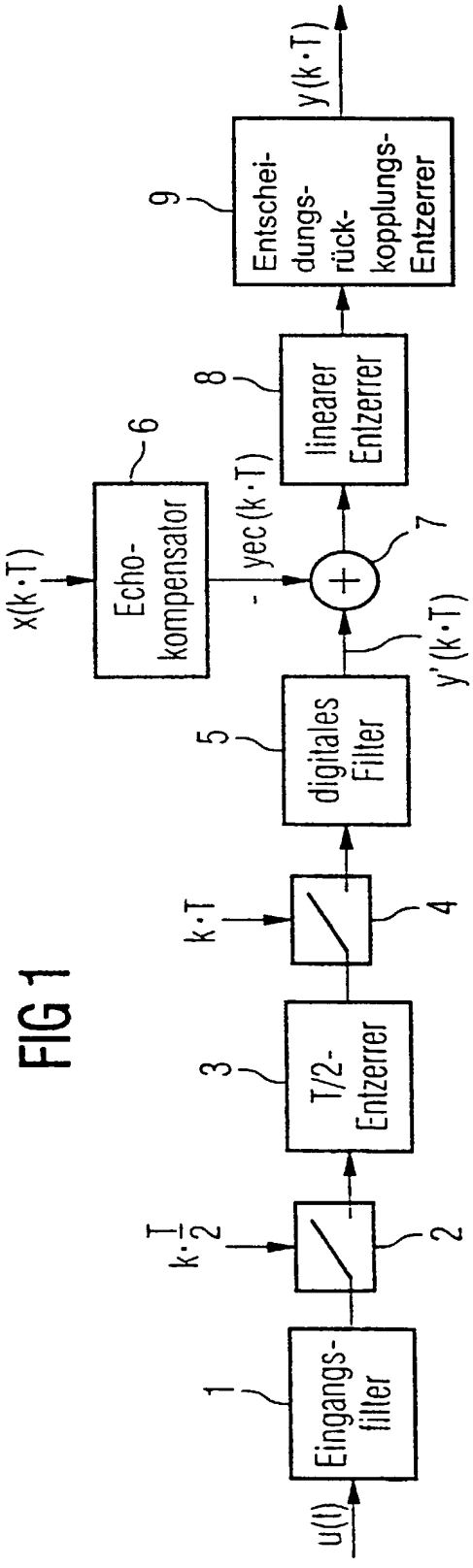

u(t)
Eingangs-filter
1
$k \cdot \frac{T}{2}$
2
T/2-Entzerrer
3
$k \cdot T$
4
digitales Filter
5
Echo-kompensator
6
$x(k \cdot T)$
$yec(k \cdot T)$
-
+
7
$y'(k \cdot T)$
linearer Entzerrer
8
Entschei-dungs-rück-kopplungs-Entzerrer
9
$y(k \cdot T)$

FIG 1

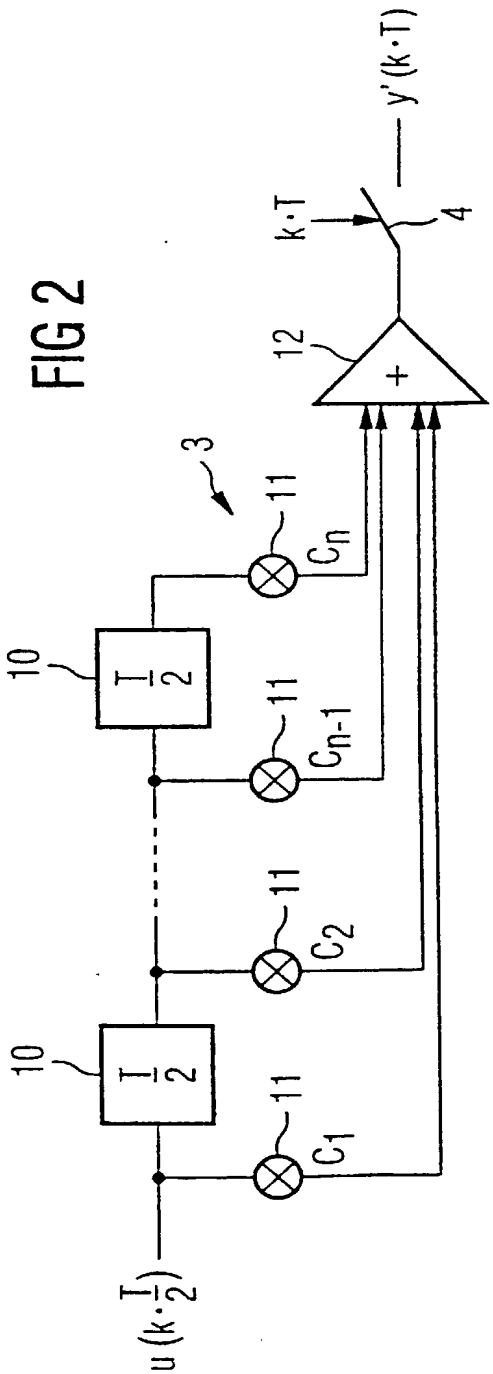

$u(k \cdot \frac{T}{2})$
$\frac{T}{2}$
10
$\frac{T}{2}$
10
3
C_1
11
C_2
11
C_{n-1}
11
C_n
11
12
+
$k \cdot T$
4
$y'(k \cdot T)$

FIG 2

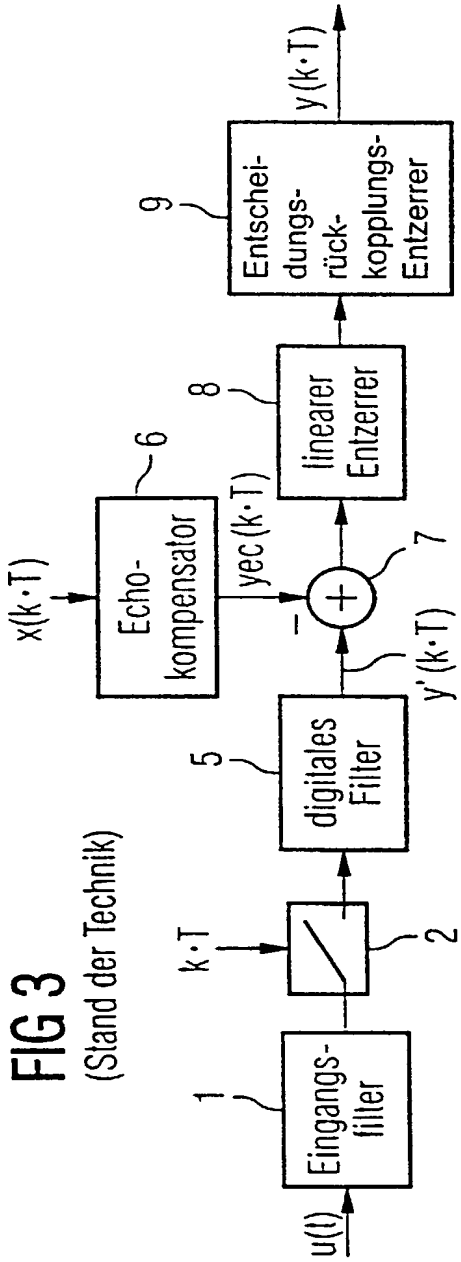


FIG 3
(Stand der Technik)

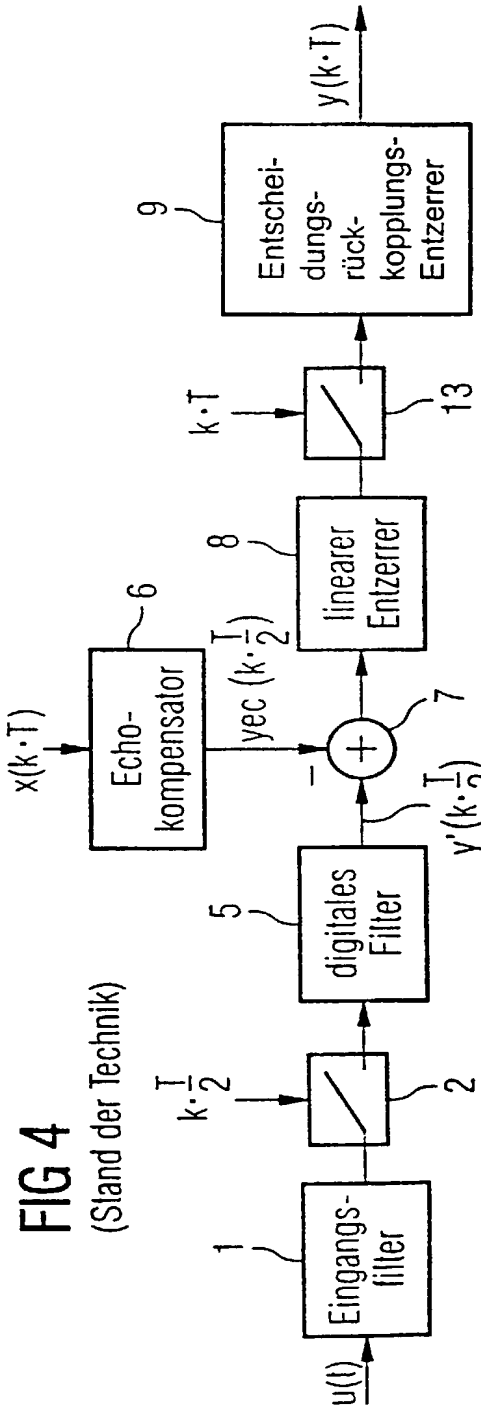
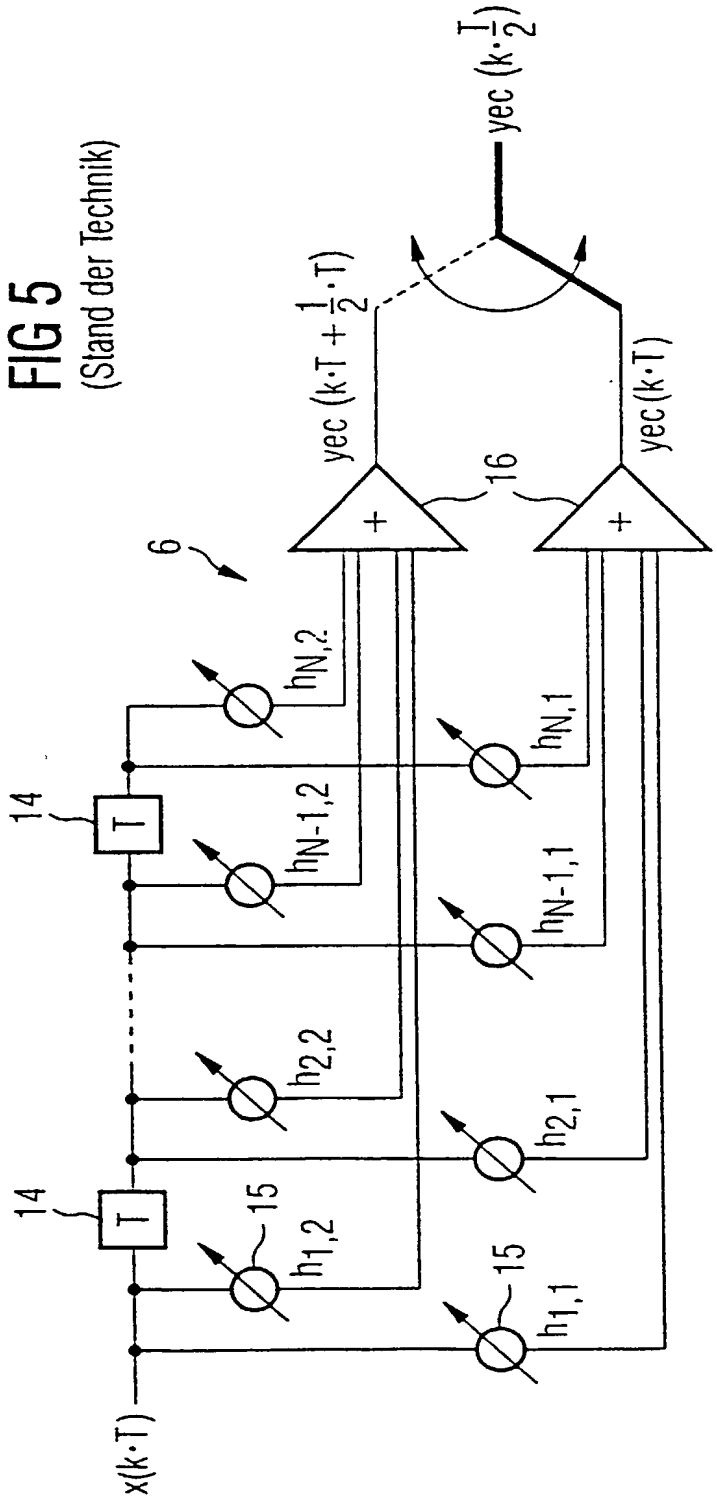


FIG 4
(Stand der Technik)

FIG 5
(Stand der Technik)



Attorney's Docket No.: 12816-044US1
Client's Ref. No.: S1692 SB/swi

COMBINED DECLARATION AND POWER OF ATTORNEY

03 JUN 2002

01/049252

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled RECEPTION METHOD AND RECEIVER ARRAY FOR A DUPLEX TRANSMISSION SYSTEM, the specification of which:

[] is attached hereto.
[X] was filed on February 8, 2002 as Application Serial No. 10/049,252 and was amended on _____.
[X] was described and claimed in PCT International Application No. PCT/EP00/07746 filed on 08/09/2000 and as amended under PCT Article 19 on _____.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose all information I know to be material to patentability in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

Country	Application No.	Filing Date	Priority Claimed
Germany	19937505.4	08/09/1999	[X] Yes [] No

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patents issued thereon.

Attorney's Docket No.: 12816-044US1
Client's Ref. No.: S1692 SB/swi

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